IX. WILLOW SCRUBS AND GALLERIES – SALICETALIA PURPUREAE

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Salicion triandrae T. Müller & Görs 1958 – Willow scrubs

Coenosystematic state of willow scrubs

At the beginning of the Central-European coenological surveys, all kinds of the willow communities developing on the flood area were classified as *Saliceto-Populetum* (Tx. 1931) included in the alliance *Salicion albae*.

The willow scrubs were not described as separate associations, they were regarded as initial steps of succession and were considered just a facies of the gallery forest (*Populeto-Salicetum Salix triandra* facies, Timár 1950) or – as in Simon's opinion – a stadium of it (*Populeto-Salicetum Salix triandra* stad. Simon 1954). During his research at Szigetköz, Zólyomi mentioned a mixed stadium which was formed with *Salix triandra* and *S. purpurea* (Kárpáti 1958).

In the synopsis of Soó, however, the willow scrubs were included in a distinct alliance (*Salicion triandrae* Müller-Görs 1958), and Soó distinguished two associations – *Salicetum purpureae* and *Salicetum triandrae* (Soó 1964). The weedy types of the willow scrubs were classified into the *Calystegion* alliance (Soó 1960).

In this paper Soó's classification-system – date from 1964 – is presented considering also the recent nomenclature. Kevey revised the association-nomenclature first in 1995 on the basis of his works at Szigetköz (Bartha *et al.* 1995), and changed the names of the two above associations for the very similar *Rumici crispi-Salicetum purpureae* Kevey in Borhidi & Kevey 1996 and *Polygono hydropiperi-Salicetum triandrae* Kevey in Borhidi & Kevey 1996 (Borhidi 2003).

In the followings, we use the latest nomenclature.

Short historical review

Soó was the first who described willow scrub stands along the river Szamos in 1927 (Újvárosi 1940). Later, coenosystematic researches were carried out along the river Danube, and several important results were published by Zólyomi (1937) and Kárpáti (1958). During his researches, Timár published very detailed coenological data from the floodplain forest-associations along the rivers Tisza and Maros (Timár 1950a, 1950b). Simon documented very thoroughly the willow scrub stands along the Upper-Tisza section (Simon 1957). Tóth carried out important

vegetation-surveys along the Maros at the 1960s (Tóth 1967). Kevey revised the coenosytematic relations of the willow scrubs, his works focused mainly on the stands along the river Danube (Bartha *et al.* 1995).

IX.1 *Rumici crispi-Salicetum purpureae* Kevey in Borhidi & Kevey 1996

Syn: *Salicetum purpureae* Kárpáti 1958
(not found along the Tisza and its tributaries)

Environmental conditions

The stands of this association develop on shoals of gravel and coarse sand, where the current of the river is very strong. The water regime of these shoals is very extreme: in the case of low water-level they dry up easily, and water-level rises very fast and high at the time of flooding (Bartha *et al.* 1995).

According to the literature, this association is missing from the Hungarian section of Tisza because of the above mentioned habitat demands. It may be present along the upper part of the river, near the riverhead.

IX.2 *Polygono hydropiperi-Salicetum triandrae* Kevey in Borhidi & Kevey 1996

Syn: *Salicetum triandrae* Malcuit 1929, *Salicetum triandrae-purpureae* Soó 1927, *Populeto-Salicetum Salix triandra* facies Timár 1950, *Populeto-Salicetum triandrae* Timár 1950.

Salicetum triandrae association is the willow scrub that is spread along all of the rivers at the Great-Hungarian Plain (Soó 1960).

Environmental conditions

The stands of this association develop along the slow-flowing river sections and backwaters on fine sand and silt. These fine grained sediments have better water retention capacity, thus the water regime of this kind of habitat is more balanced then that of the previous community. Stands could be waterlogged for over 5-7 month a year, therefore the soil formation is rather restricted (Borhidi 1999). This community can be considered local association specific in the Carpathian basin (Borhidi 2003).

Description of the stands along the River Tisza and its tributaries

Soó stated in 1960, that "on the Great-Hungarian-Plain the most exhaustively investigated and best-known forests are the floodplain forests…" (Soó 1960). Unfortunately, our knowledge about the Hungarian willow scrubs did not increase

substantially so far, as can be seen from the literature. All of the traceable relevés were taken on Braun-Blanquet scale, and only two of the 90 relevés represented the state of the willow scrubs in turn of the millennium.

The relevés taken along the river Tisza were analysed in three sections – lower, middle, upper – defined by Pécsi (1969). In the case of the tributaries we did not apply any finer distinction.

Lower-Tisza

The analysis of the vegetation of this section was made mainly from the relevés of Timár.

The following species occurred with high constancy and considerable cover (constancy values are in brackets): *Salix triandra* (V), *Bidens tripartitus* (V), *Agrostis stolonifera* (IV), *Echinochloa crus-galli* (IV), *Persicaria lapathifolia* (IV). Altogether 19 species were present with high constancy (V-III). Considering the average cover, most of the species had low AD values (+-1). *Populus nigra* was found in many stands (K=IV) but with very low coverage (+-1). *Populus alba* and *Salix alba* occurred just in few stands but with higher coverage (1-2). The appearance of *Ulmus glabra* was surprising in these stands, probably it was planted. Altogether 122 species were recorded, three of them are remarkable because nowadays are rarely found along the river: *Aster amellus, Gratiola officinalis* and *Tussilago farfara*.

Timár reported that the branches of the willow scrubs were cut down regularly, thus the trees grew close to each other, and the herb layer was rather sparse or nudum. He mentioned that mainly *Elymus repens* and *Agrostis stolonifera* dominated herb layer developed on the open stands (Timár 1950/a, 1950/b). Soó interpreted Timár's stands as a secondary weedy gallery forest after clear-cutting (Soó 1960).

Middle-Tisza

The description of the vegetation of the Middle-Tisza section originates from the examinations of Timár and Újvárosi. Timár investigated the riverbed in the Middle-Tisza region near Tiszaföldvár and Szolnok (Timár 1950/a). Újvárosi worked between Polgár and Tokaj (Újvárosi 1940). Other surveys referring to the willow scrubs have not been carried out till now.

The most abundant and frequent tree-species were in the stands *Populus nigra* (IV) and *Salix triandra* (IV). *Populus alba* also occurred several times (III) but with lower coverage (1-2). *Salix viminalis* dominated just a single stand. Most of the stands were dominated by a single tree species, other trees just mixed sparsely with the dominant species.

Characteristic species of the herb layer were: *Agrostis stolonifera* (IV), *Bidens tripartitus* (IV), *Elymus repens* (III), *Convolvulus arvensis* (III), *Gnaphalium uliginosum* (III), *Rorippa sylvestris* (III).

One hundred and forty-two species were found in the relevés, 17 of them had high constancy values (IV-III), most species occurred sporadically: 124 of the 134 herbaceous species had got +-1 AD range, and only 6 of the subordinate species had higher (III) constancy values. The flora was dominated by ruderal elements and mud vegetation.

Újvárosi published a synthetic coenological table on the basis of 25 relevés from the Polgár-Tokaj section (Újvárosi 1940). In this area, *Salix triandra* had the highest constancy value and average cover in the canopy layer, other species occurred sporadically. This may be resulted because Újvárosi took relevés close to the riverbank. Frequent species of the herb layer were: *Persicaria lapathifolia, Conyza canadensis, Echinochloa crus-galli, Bidens tripartitus, Chenopodium urbicum, Cyperus fuscus, Digitaria sanguinalis, Gnaphalium uliginosum, Plantago major, Potentilla supina, Rorippa sylvestris.*

Total number of the species was 99 on this section.

Upper-Tisza

We analysed the vegetation of the Upper-Tisza section on the basis of Simon's work (Simon 1957).

Only two species were both abundant and frequent – *Salix triandra* (IV), *Populus nigra* (III) – other species occurred with rather low AD values (+-2): *Bidens tripartitus* (IV), *Elymus repens* (IV), *Lycopus europaeus* (IV), *Echinocystis lobata* (III), *Salix alba* (III). Some species, such as *Salix viminalis, Rubus caesius* and *Equisetum arvense,* occurred only in a few stands but with high local coverage. Altogether 65 species were found in the relevés, neither of them was typical mountainous species. Protected species of this section was *Salix elaeagnos*.

Szamos

Data have been published only from three stands, thus this short description may not be considered representative in respect to all this river. Frequent and abundant species were *Salix triandra* (V), *Phragmites australis* (IV), *Rubus caesius* (IV), *Amorpha fruticosa* (IV). Other frequent species were *Bidens tripartitus, Lycopus europaeus, Salix viminalis, Equisetum fluviatile.* Total species-number of the relevés was 33.

Körös

Only few data from two stands were available in the literature. Two recent relevés published by C. Dragulescu consisted of 35 species, and only three of them were present with higher abundance: *Salix triandra, S. alba* and *Rubus caesius*.

Maros

Timár and Tóth recorded relevés from 15 stands along this river. On the basis of their works, the most abundant species of the canopy layer was *Salix triandra* (V). In some stands *Populus nigra* (II), *Populus alba* (II) and *Salix alba* occurred with lower coverage. *Amorpha fruticosa* (III) was present in the shrub layer of several stands. Frequent species of the herb layer were *Bidens tripartitus* (V), *Calystegia sepium* (IV), *Erigeron annuus* ssp. *strigosus* (IV), *Lycopus europaeus* (IV), *Rubus caesius* (IV), *Potentilla supina* (IV), *Agrostis stolonifera* (III), *Echinochloa crus-galli* (III), *Persicaria lapathifolia* (III), *Phragmites australis* (III), *Scutellaria galericulata* (III). Altogether 117 species were recorded in the Maros-relevés.

Multivariate analyses

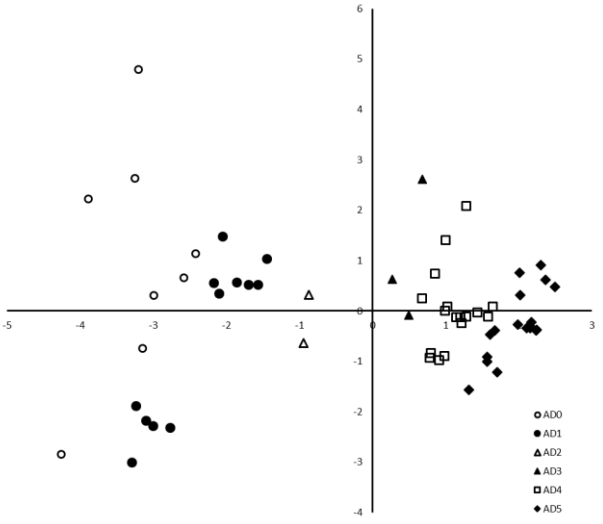

Fig. 1. Scatterplot of the ordination of willow scrub relevés (centered PCA). The distribution of the points is determined by the dominance (AD values) of *Salix triandra* along the first axis.

Sixty relevés were evaluated with Principal Component Analysis (Centered PCA). Number of species was rather high, 235 species were included in the analysis. As a result, 10 variables accounted for 73.99 % of total variance. On the other hand, the points do not show marked aggregations. The distribution of the points is determined mostly by *Salix triandra*. This species dominates 2/3 of the relevés and is absent only from 8 relevés. Thus the distribution of the points along the first axis is connected to the AD-values of *Salix triandra*; AD-values are high in the right-side aggregations and low in the left-side ones. No clear connection was found with the geographic distribution of the stands neither with the presence of other species.

Summarised evaluation

Considering all the river sections and tributaries, the following conclusions were taken:

1. *Salix triandra* was present with high constancy (III-V) and AD values (1-5) in each river sections. In the herb layer *Bidens tripartitus* was the constant element with higher AD values, and *Lycopus europaeus* was found in the majority of the stands, but with low range of AD values (+-1).

A permanent species-composition could not be organized as a consequence of the extreme and quickly changing environmental conditions of this habitat-type. This natural disturbation effect of floods can be tolerated mainly by the natural pioneers (just the elements of *Nanocyperetalia*) and disturbance tolerant plants. Thus the herb layer assembled from these kinds of plant species with changing proportion site by site.

2. Several authors noted that the willow scrubs became weedy due to the regular and intense cutting (Újvárosi 1940, Timár 1950, Soó 1960). These weedy willow scrubs were classified among the *Calystegion* alliance in the early studies.

3. Our field observations suggested that nowadays the willow scrub stripes do not develop very definitely along the riverbanks. This may be explained by the fact that after the river regulation the current of the widely meandering and shoal-building rivers was speeded up due to the cut-off of the river bends. Thus the length of the building banks decreased, and the bank of the deepening riverbed became steeper. The widely extending, continuously moving and changing flat floodplains are rather rare along the river therefore the development of wide willow scrub stands is prevented.

Willow scrubs are endangered by more and more extreme floods because the willow species can not tolerate the long-lasting submerged state of the entire foliage. Willow species are sensitive to the water cover in different degrees: *Salix purpurea* and *S. triandra* tolerate relatively well the inundation unlike *S. fragilis* and *S. viminalis* (Bordács, personal communication).

Salicion albae (Soó 1930 em. Müll. Et Görs 1958) – Gallery forests

IX.3 *Salicetum albae-fragilis* Soó 1957

Considering that the recent nomenclature (Borhidi 2003) of the gallery forests was based on the examination of the Danube stands, we have decided to use the comprehensive name of the willow-poplar gallery forests given by Soó.

Syn: *Salicetum albae-amygdalinae* (Slavnic 1952), *Salicetum mixtum* (Soó 1936), *Saliceto-Populetum albae* Timár (1952, 1953, 1954) *Salicetum albae-fragilis hungaricum* Soó 58.

Short historical review

The researches in connection with the Hungarian floodplain gallery forests started at the 1950s. Kárpáti was the first who described the willow gallery forests in the Szigetköz (Kárpáti 1957). Kevey has carried on with his works and one of his most important results was to clarify the coenosystematic relations of the floodplain forest along the River Danube (Kevey 1993).

Simon worked on the Upper-Tisza section and documented the vegetation with coenological relevés (Simon 1957). Timár revealed the riverside forests of the Lower-Tisza region (Timár 1950). The vegetation studies of Tóth provided important knowledge from the Maros floodplain (Tóth 1967). Soó's scientific achievement should be emphasized with regard to clarifying the European state of the Hungarian stands (Soó 1973).

Changes in the nomenclature of the gallery forests

The alliance *Populion albae* Br-Bl. 1931 ex Tchou 1948 was described in the Mediterranean region. Soó realized that the name *Salicetum albae* described by Issler (1926) refers to the western types of the gallery forests which spread to Eastern-Austria, and it is synonymous with the name *Salicetum albae-fragilis* used by Tüxen 1955. Since the southeast- and east-European stands were significantly different from these gallery forests considering the species composition, Soó classified them in a separate alliance: *Salicion albae* Soó 1930. Soó used the name *Salicetum albae-fragilis hungaricum* already in 1933, and gave this name to the Hungarian gallery forest in 1958. He mentioned the following characteristic species: *Fraxinus angustifolia* ssp. *pannonica, Vitis sylvestris, Glycyrrhiza echinata, Oenanthe banatica, Lycopus exaltatus, Leucanthemella serotina, Leucojum aestivum*. Soó distinguished two regional types within this association: *Salicetum albae-fragilis tibiscense* and *danubiale*. In connection with the stands along the River Tisza, he mentioned some differential species referring to Újvárosi's (1940) study: *Cnidium dubium, Echinocystis lobata* (Soó 1973).

Previously the white poplar forests were thought as a secondary-type of the elm-ash-oak forest after clear-cutting (Kárpáti 1958/b). Nowadays the white poplar forests developed on the low floodplain flats are considered natural stands which indicate the effects of the Sub-Mediterranean climate, and the *Populus alba* becomes more frequent towards the Mediterranean. Therefore we can consider our gallery forests (dominated by *P. nigra* and *Salix alba*) as local associations in the Carpathian basin (Borhidi 2003).

The very first scientific name of the Hungarian gallery forests was *Salicetum albae-fragilis* Issler 26. em. Soó 1957 (Soó 1964). Kevey divided it into two parts on the basis of his works carried out in the Szigetköz: willow gallery forest (*Leucojo aestivo-Salicetum* Kevey 1993) and poplar gallery forest (*Senecio fluviatilis-Populetum* Kevey 1993) (Bartha *et al.* 1995). The Hungarian white poplar gallery forest was not considered the same as the association known as *Populetum albae* Wendelberger-Zelinka 1952 in west-Europe (Bartha *et al.*1995).

Recent studies improved further this system: the poplar gallery forest was divided into black poplar gallery forest (*Carduo crispi-Populetum nigrae* Kevey in Borhidi & Kevey 1996) developing on the medium-high relief of the low floodplain and white poplar gallery forest (*Senecio sarracenici-Populetum albae* Kevey in Borhidi & Kevey 1996) developing on the highest relief of the low floodplain (Borhidi *et al.* 1999). These changes in the nomenclature, however, were based on the examinations of the Danube stands.

Recent results about Populus nigra

European black poplar (*Populus nigra* L.) is a characteristic pioneer species of riparian ecosystems. Its abundance and genetic diversity is threatened due to the loss of its natural habitat – by urbanization, drainage of wetlands for agricultural use, canalization of rivers for flood prevention – and the hybridization with the improved *Populus* clones. *P.×euramericana* was introduced to Northern-Europe in the 19th century (Cottrell *et al.* 2005).

Nowadays, *Populus nigra* is recognized as endangered species all across Europe, and natural populations useable for gene bank-supply disappeared from Western-Europe. The in-situ (preservation of natural stands) and ex-situ (establishing gene banks) conservation strategies applied in Hungary could support the preservation and survival of the local black poplar populations and their genetic resources. A *Populus nigra*-preservation project was elaborated in Gemenc region (Southern-Hungary) and was adopted widely in Europe: the distinction of the hybrid and non-hybrid plants is performed first on morphological level, and then, before the vegetative propagation, it is further refined with molecular (DNA) markers (Bordács *et al.* 2004).

On the basis of the recent examinations, there are essential differences in the genetic structure of the black poplar populations occurring frequently along a

certain river system. Genetic diversity does not increase upwards the river, that was assumed earlier from that the gene-flow may proceed opposite with the water flow owing to the opposite wind-flows at the river-valley. The examinations based on the chloroplast DNA (cpDNA) revealed six new haplotypes in the Hungarian samples, which are missing from the West-European populations. This indicates the conservation importance of the gene-pool of the Hungarian black poplar populations (Bordács *et al.* 2004.).

As for the Tisza basin, some black poplar populations were sampled at the surroundings of Zemplénagárd, too. The analysis of these samples and interpretation of the results are in progress (Bordács, personal communication).

The current researches based upon the examination of the chloroplast DNA (cpDNA) variation in black poplar aim the understanding of the location of glacial refugia and the subsequent postglacial routes of the recolonisation of this species. According to molecular analyses based on gene bank collections originating from seven European countries, two gene-centers (a southeastern from Italy to Austria-Hungary and a southwestern at Spain) could be separated. The exact locations of the eastern refugia were also difficult to identify accurately, because there were also several unique haplotypes in the Italian peninsula, eastern Austria and Hungary (Cottrell *et al.* 2004).

The high diversity detected by Bordács in a population growing along the Danube River in Hungary supports this statement, and indicates the necessity of the further investigations toward south and east of Hungary to confirm the existence and location of this putative refugium (Bordács *et al.* 2002).

The phylogenetic analysis showed that three haplotypes (two from Germany and one from Hungary) were very different from the other haplotypes that were detected in the study, and these samples produced the banding pattern typical of the 'Thevestina' clone (Vencsura 1992). Thus these haplotypes might therefore be distinct because they originated from the same area as 'Thevestina', which itself originated from the Central Asian and Black Sea region and has been widely used as ornamental tree. This highlights the need to extend the sampling to regions further east (Cottrell *et al.* 2004).

Environmental conditions

The gallery forests are edafic associations along the rivers, their stands evolve in the low floodplain flats behind the willow scrub zone. Their development is attached to the more or less regular inundations, and their flora is adapted to these extreme natural disturbation effects with a specific reproduction strategy and habitat-demand in evolutionary time. Stands tolerate the permanent water-coverage over three or four month, and develop on crude alluvial soils (muddy sand, fine sand, medium bound soils) (Borhidi *et al.* 1999).

Description of the stands along River Tisza and its tributaries

For the sake of the easier survey we classify and analyse the coenological data along the River Tisza in different sections.

Explanation of the dissections:

1. The River Tisza section from the southern frontier to Szolnok was surveyed very thoroughly. On the basis of our field experiences the natural vegetation survived in this region in low proportion. The flora of the different associations was very poor in species and the vegetation types have become very homogeneous. Because of the lots of relevés collected from this section we divided it into two parts: from the frontier to Csongrád and from Csongrád to Szolnok.

2. The Szolnok-Tokaj section is almost completely overlapped the Middle-Tisza region and this could support the decision to discuss separately this section from the others in spite of the few relevés.

3. Areas lying north of Tokaj represented the Upper-Tisza section.

4. Vegetation of Köröszug and Bodrogzug have special locality, because the areas lie at the junction of two rivers (Tisza and Körös/Bodrog), therefore the relevés taken from these two sections are distinguished from the others.

5. In the case of the tributaries we do not use any finer division.

6. We distinguished the willow dominated vegetation types developed on navvy holes next to the floodplain slopes of the dikes (kubikfüzesek) from the gallery forests of the riverbank. These depressions are under the influence of permanent water coverage for long time of a year therefore their vegetation-types escape from the intensive land use. Till the middle of the last decade, basket-makers cut and collected the osiers of these willow-forms, which made their physiognomy very characteristic. They were called “botolófüzes”. This type of management has terminated by nowadays and the less disturbed forest stands serve as refugee-areas for the flora and fauna (Molnár *et al.* 1997).

7. For all river sections, percentage cover (%) and Braun-Blanquet scale (AD) data were handled separately, because the percentage data were usually recorded later than the other type, and on the other hand the numerical analysis of mixed data is very problematic.

The distinguished river sections will be discussed in the following order: first the different Tisza-sections are analysed starting from the southern border towards the Upper-Tisza. The vegetation of Köröszug and Bodrogzug will be treated together with the respective Tisza sections. Tributaries are also discussed from south to north.

The synthetic table contains the average cover and constancy values of the species for each section. Also the overall constancy is given.

To give properly constancy values, it is important to know the number of stands. We determined this number primarily from literature data: all sampling sites given by the authors were considered separate stand, even if only one relevé was

taken (e.g. Simon 1967). If the relevés were not grouped in stands by the author but vegetation map with marks of relevés was enclosed, we decided the number of stands and number of relevés belonging to a certain stand (e.g. Deák 2001).

In some cases the stands were delineated on the basis of aerial photos. We ranked the relevés in the same stand if they were taken within a distance of several hundred meters in a narrow belt along the river.

Unpublished data from György Bodrogközy were evaluated on the basis of his field notes; we considered the relevés of a table as members of the same stand.

From the southern frontier to Csongrád

Gallery forests

Recently, the intensive agricultural and silvicultural land uses are characteristic in this river section. The gallery forests can often survive just along the riverbank in a width of one or two rows of trees. The stands are strongly disturbed and quite poor in species. The proportion and number of invasive species are very high. Altogether 79 species were recorded in the relevés of this section. Adventive species were strongly determinant in community-composition.

Species in decreasing order of coverage were the following (constancy values are in brackets): *Fraxinus pennsylvanica* (V), *Salix alba* (V), *Rubus caesius* (V), *Amorpha fruticosa* (V), *Populus nigra* (IV), *Populus alba* (IV), *Acer negundo* (V), *Vitis riparia* (III). This order was established from the greatest average cover values of the species in the vegetation strata. Some species, first of all the adventive, invasive plants like *Acer negundo, Fraxinus angustifolia, Amorpha fruticosa, Vitis riparia*, were present in more than one layer, thus in this case their total average cover values were much higher.

The most dominant species of the herb layer were *Bidens tripartitus* (V), *Urtica dioica* (V), *Aristolochia clematitis* (V), *Glechoma hederacea* (III). Other species occurred with very low constancy and average cover values. Important and valuable species of the relevés were *Salvinia natans*, *Cucubalus baccifer, Iris pseudacorus*.

AD-scale (Braun-Blanquet scale) data were reported from three stands in the 1960s. The vegetation of these stands had very scarce canopy. Altogether 77 species were present in them, and dominant species were *Rubus caesius* (V), *Elymus repens* (V), *Calystegia sepium* (V), *Salix triandra* (V), *Calamagrostis epigeios* (V). The only valuable plant species was *Leucanthemella serotina*.

Willow stands along the dikes (kubikfüzes)

Characteristic species of these stands were almost the same as those of the sandbank gallery forests: *Salix alba, Fraxinus pennsylvanica, Rubus caesius,*

Amorpha fruticosa, Bidens tripartitus. Constancy of *Aristolochia clematitis* was high (IV) but its average cover was rather low in contrast to *Symphytum officinale*, which occurred with high coverage in few stands and had low (II) constancy. The following frequent species occurred in many stands with very low average cover: *Echinocystis lobata* (IV), *Lysimachia vulgaris* (III), *Iris pseudacorus* (III), *Lythrum salicaria* (III). The rest of the plant species was sporadic. The stands were very poor in species according to the relevés, only 31 species were recorded.

Köröszug

Gallery forests

This area lies in the junction of the rivers Tisza and Körös. It can be distinguished from the neighbouring areas because it belongs to the Danube-Tisza Interfluve region in evolutionary aspect.

The following species occurred with high constancy and coverage values in the relevés: *Salix alba* (V), *Fraxinus pennsylvanica* (V), *Amorpha fruticosa* (V), *Populus canescens* (IV), *Bidens tripartitus* (IV), *Rubus caesius* (IV). *Acer negundo* (II) was found just in a few stands with relatively high coverage. *Lysimachia vulgaris* (III), *Echinocystis lobata* (III), and *Urtica dioica* (III) existed in several stands but with low coverage. The other species occurred with low constancy and average cover. Altogether 87 species were present. The only valuable plant was *Allium angulosum*.

Willow stands along the dike (kubikfüzes)

Species occurring with high cover had also high constancy values on the basis of the coenological relevés (*Bidens tripartitus, Salix alba, Fraxinus pennsylvanica, Amorpha fruticosa, Symphytum officinale, Rubus caesius*). The flora of this river section was very poor in species (altogether 44 species were recorded). Its protected plant was *Cirsium brachycephalum*.

According to Timár, the vegetation of these pits along the dike should be less grazed, thus they could function as refugee-area maintaining the biodiversity of the local flora and fauna (Timár 1953). Our field experience did not verify this statement; the reason for this could be the impoverishment of the regional species pool.

Csongrád - Szolnok section

Gallery forests

Recently, the most abundant species in this section was *Fraxinus pennsylvanica*. It occurred in each layers with high coverage thus its average cover value was the highest compared to those of the other plant species. In addition, the following species were found with quite high constancy and cover values: *Populus nigra* (V), *Salix alba* (V), *Rubus caesius* (IV), *Acer negundo* (V), *Amorpha fruticosa* (IV), *Populus alba* (III), *Echinocystis lobata* (III). Among the herbaceous plants *Urtica dioica* had the highest coverage, but this value was quite low compared to the upper layers. The relevés consisted only of 33 species. Apparently woody plantations and invasive species were dominant in the stands.

Some of the relevés date from the end of the 1970s (Horváth *et al.* 1978), and others were recorded in this section more than 60 years ago (Timár 1950). Floristic composition of the stands can be regarded more natural on the basis of ancient data, than of the recent ones. Dominant species were *Rubus caesius, Salix alba, Aristolochia clematitis, Populus alba, Populus nigra*. From among the invasive species only *Amorpha fruticosa* could be reckoned among the dominants. Considering the natural association-forming species, *Salix alba* (V), *Populus alba* (III) and *Populus nigra* (III) were found in the majority of the stands. Hybrid poplar plantations are also present in this section, and their proportion is increasing. Valuable species recorded in this community were *Leucojum aestivum, Gratiola officinalis* and *Eryngium planum*. Altogether 109 species were counted in the old relevés. Compared to this number, the low species number of the recent relevés indicated a very fast impoverishment trend of the community.

Szolnok-Tokaj section

Gallery forests

Újvárosi published a synthetic coenological table from the Szolnok-Polgár section on the basis of 20 relevés (Újvárosi 1940). This article was used by Soó to describe the gallery forest along the Tisza (Soó 1973). In addition to these data we found only 3 further relevés made by Bodrogközy, but they were not comparable with those of Újvárosi and were not included in further numerical analyses.

Bodrogközy's data show observations similar to those recorded in the river sections described above. The herb layer was species rich, 56 herbaceous species were recorded. *Urtica dioica* and *Poa trivialis* were the most dominant, other species occurred sporadically. Shrub layer was sparse, it was composed of mainly *Amorpha fruticosa* and *Celtis australis*. *Cornus sanguinea* was present as the only

natural gallery forest shrub species. *Salix alba* and *Populus alba* dominated the canopy.

The species-composition of the canopy was very diverse in Újvárosi's relevés. Beside the generally occurring plants – *Populus alba* (III), *P. nigra* (II) – four willow species – *Salix triandra* (V), *S. alba* (III), *S. fragilis* (III), *S. viminalis* (II) – were detected. Újvárosi revealed *Alnus glutinosa* (I) and *Ulmus glabra* (I) in this river section, which are very rare in Hungary. The shrub layer was rich in natural association-forming species (*Ligustrum vulgare, Rhamnus cathartica, Crataegus monogyna, Frangula alnus, Malus sylvestris, Cornus sanguinea*), but these occurred with very low average cover and constancy values. Only two invasive species (*Amorpha fruticosa, Acer negundo*) were found. Frequent and generalist species of the herb layer were: *Poa palustris* (V), *Aristolochia clematitis* (III), *Calystegia sepium* (III), *Cucubalus baccifer* (III), *Lysimachia nummularia* (III), *Stachys palustris* (III), *Cuscuta lupuliformis* (III), others were sparse. According to the relevés, the flora of this section consisted of 99 species. Valuable plants were: *Cnidium dubium, Epipactis purpurata, Iris sibirica, Leucanthemella serotina, Leucojum aestivum*.

Bodrogzug

Gallery forests

The rivers Bodrog and Tisza join at Tokaj forming a common floodplain, this is the reason why this section is distinguished from the others.

The flora of this river section was rather poor, altogether 95 species were found, but this can be explained with the low number of the relevés.

Frequent and abundant species were *Salix alba* (V), *Populus alba* (IV), *Rubus caesius* (IV), *Populus nigra* (III), *Fraxinus pennsylvanica* (III), *Lysimachia nummularia* (V), *Lycopus europaeus* (V). *Ulmus laevis* reached high constancy but very low AD values in the relevés. Some forest species appeared also in the stands: *Geum urbanum, Angelica sylvestris, Galeopsis pubescens, Aegopodium podagraria*.

Tisza section north of Tokaj

Gallery forests

Most of the relevés taken in this region originate from the middle of the last century and were recorded on AD-scale. Only one stand was represented by relevés taken on percentage scale with 51 species, and its abundant plants were *Rubus caesius, Salix alba, Fraxinus angustifolia, Amorpha fruticosa, Glechoma hederacea.*

Simon documented very thoroughly the vegetation of the upper-Tisza section in the 1950s (Simon 1957). We used mainly his data in the evaluation. In addition to this, Dragulescu took relevés in four stands partly in the Ukrainan section of the river in 1995.

On the basis of the above data, predominating species of the stands were *Rubus caesius* (V), *Salix alba* (IV), *Populus nigra* (IV), *Urtica dioica* (V), *Stachys palustris* (III), *Lycopus europaeus* (III), *Agrostis stolonifera* (III). *Amorpha fruticosa* was missing from Dragulescu's data. In general we can say that a few species had high coverage, and several native accompanying species occurred with low abundance as colouring elements. The number of protected plants was significantly higher in this section: *Acer tataricum, Aegopodium podagraria, Anemone ranunculoides, Athyrium filix-femina, Circaea lutetiana, Clematis vitalba, Convallaria majalis, Leucanthemella serotina, Leucojum aestivum, Polygonatum odoratum*.

This section had the highest species diversity, its flora consisted of 213 species that should be caused by several factors. Continuous species immigration from the surrounding mountainous areas can basically result in higher species number in contrast to the stands developed on the Great Hungarian Plain far away from this species pool. On the other hand, most of the relevés were taken at the 1940-50s, when the intensive human influence that affected more the lowland region was not so considerable, yet.

River Maros

We analysed the gallery forests along the river Maros by dividing the relevés into two groups according to their locality. We distinguished the Hungarian section affected by intensive human land use, and the more natural Romanian stands. Tóth took relevés on Braun-Blanquet scale on the Hungarian section in the 1950s, and we evaluated her data separately from the others (Czúcz, Révész, Margóczi, Makra and Penksza) within the Hungarian section because of different data scales and the long temporal distance.

The following species occurred with high constancy values and average cover in all the relevés *Salix alba, Rubus caesius, Urtica dioica, Populus alba*.

Gallery forests at the Hungarian section

In addition to the above mentioned species, further ones were present with high constancy and average cover values in the relevés of the Hungarian section in the 1950s: *Populus nigra* (IV), *Lysimachia nummularia* (III), *Aristolochia clematitis* (IV), *Calystegia sepium* (V), *Agrostis stolonifera* (IV). Several protected species were also recorded: *Cephalanthera damasonium, Epipactis helleborine, Clematis integrifolia, Leucojum aestivum, Vitis sylvestris*. Total number of the occurring

species was 181. Climber plants were represented with low constancy and cover values that could refer to the regular land use and more intensive human disturbances (for example: fishing, basket weaving, brushwood gathering).

In the recently taken relevés lots of adventive species were recorded on the Hungarian section, which had high constancy values (*Amorpha fruticosa* (V), *Acer negundo* (III), *Fraxinus pennsylvanica* (III)). These species often dominated in the lower layers as seedlings and saplings, too. The forest plantations (both hybrid poplar and native trees) occupied large areas on the floodplain and their flora considerably differed from the natural community composition. In the plantations the following species proved to be frequent: *Ulmus laevis, Morus alba, Celtis occidentalis, Quercus robur.* Relevés containing *Populus nigra* (III) and *Populus alba* (IV) can not be distinguished unambiguously from each other. One natural association-forming species, *Cornus sanguinea* (IV) was frequent in the stands and just one protected species (*Epipactis helleborine*) occurred. The flora of this type was composed of 78 species.

Gallery forests at the Romanian section

The species number was significantly higher on the Romanian section, altogether 158 species could be listed. Predominant species of the relevés were *Salix fragilis, Populus alba, Ranunculus repens, Helianthus decapetalus, Sambucus nigra, Amorpha fruticosa*. Many species occurred with high constancy but low coverage: *Agrostis stolonifera* (IV), *Urtica dioica* (IV), *Glechoma hederacea* (IV), *Aegopodium podagraria* (III), *Echinocystis lobata* (III), *Humulus lupulus* (III), *Gallium aparine* (III). Several elements of the mountainous flora were present: *Aegopodium podagraria, Angelica sylvestris, Anthriscus caucalis, Circaea lutetiana, Galeopsis speciosa, Heracleum sphondylium, Polygonatum latifolium, Alnus incana*. Some species protected in terms of the Hungarian law were recorded e.g. *Tamus communis, Telekia speciosa, Clematis integrifolia*.

River Körös

Gallery forests

The research intensity of the gallery forests along the river Körös is not satisfactory therefore we found very few data (only from two stands), and the adequate description of this section needs further researches. The following species occurred in both stands: *Echinocystis lobata, Salix alba, Salix fragilis, Artemisia vulgaris, Urtica dioica,* and these were at the same time the most abundant species. Most of the species fell in the range of +-1 AD values. Altogether 50 species were reported. Rare species of this section was *Alnus glutinosa* from the Romanian section of the White-Körös.

River Bodrog

Gallery forests

The relevés came from four different habitats therefore this analysis can not be considered as representative. Altogether 72 species were reported from the relevés.

Characteristic species of this section were *Rubus caesius, Populus alba, Populus nigra, Salix alba, Fraxinus pennsylvanica, Lemna minor, Spirodela polyrhiza*. Usually one tree species (mainly *Populus nigra* or *Salix alba*) was dominant in the canopy, others were present with lower coverage. In some cases, the values of the synthetic table could be misleading because of the few relevés. For example: *Convallaria majalis* occurred with high average cover, but had very high abundance just in a single relevé (85 %) of one stand. Protected/valuable species which appeared in the relevés were not very typical of gallery forests, they indicated other environmental influences (mountainous climate, permanent water cover): *Leucojum aestivum, Convallaria majalis, Iris graminea, Salvinia natans, Pyrus pyraster*.

River Szamos

Gallery forests

We evaluated the gallery forests along river Szamos on the basis of data from eleven stands. Data came from Dragulescu and Simon (Simon 1957). *Salix alba* was found in the highest coverage in certain places mixed with *Salix fragilis* and *Populus nigra*. The following species were dominant: *Rubus caesius* (V), *Populus nigra* (IV), *Salix alba* (V), *Amorpha fruticosa* (III) in most of the relevés. *Populus alba* had no important role, it was recorded only in four stands out of the eleven with +-1 AD values. Further frequent species were *Agrostis stolonifera, Urtica dioica, Helianthus decapetalus, Calystegia sepium, Taraxacum officinale* in the herb layer. *Amorpha fruticosa* was a typical element of the vegetation composition just at the region of Szamosbecs, in other sites it was present with much lower AD and constancy values.

Further 10 cenological relevés were taken by Fintha at Szamosbecs (Fintha 1969), but he used a modified AD scale with unknown scaling therefore his data are not included in this paper.

Multivariate evaluation

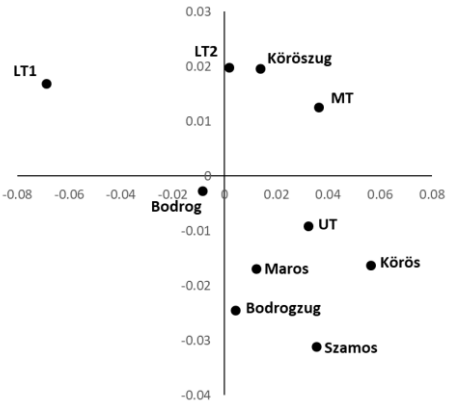

Fig. 2. Scatterplot of the ordination of gallery forest relevés (NMDS, ordinal variable, Gower index). Only centroids of ten groups are marked. LT1: Lower Tisza section 1; LT2: Lower Tisza section 2; MT: Middle Tisza section; UT: Upper Tisza section.

Two hundred and fifty relevés were evaluated with Non-metric Multidimensional Scaling (NMDS, ordinal variable, Gower index). Number of species was rather high, some 400 species were recorded in the relevés but only 223 species occurred with more than 1% frequency. Due to the large number of relevés, we do not indicate all the points in Figure 2 but the centroids of the ten regional groups. The points do not show marked aggregations, the groups broably overlap; only a weak trend can be detected from lower Tisza sections towards the Northern border. Centroids (and also the point clouds) of upper Tisza, Szamos, Bodrog, Körös and Maros are comparatively separated from the others, indicating a certain effect from the Transylvanian floristic region.

Summarised evaluation

Considering all the river sections and tributaries, we can draw the following conclusions:

1. *Salix alba, Populus nigra, Rubus caesius* and *Urtica dioica* can be regarded as constant association-forming elements (occurring with high constancy and average cover). Other frequent species were *Lysimachia nummularia, L. vulgaris, Glechoma hederacea.*

2. *Populus alba* and *Populus nigra* occurred with changing constancy values along the river.

3. The classification of the willow-poplar gallery forests existing along river Tisza is difficult according to the recent nomenclature on the basis of the available relevés. First of all, the samples do not completely fulfil the statistical requirements, thus the proportion of certain association types and the differences among the stands can not be regarded as representative of the whole Tisza section. Lots of background information are missing (for example: exact locality of the stands, relief characteristics, quadrate size, complete coenological data including the whole vegetation period, number of the relevés taken in a single stand etc.).

Recently, majority of the stands is plantation in the whole Tisza valley (mainly in the lower and middle Tisza sections), in contrast to Timár's experiences in the 1950s (Timár 1953). Therefore, the natural and semi-natural vegetation types were forced back into small patches. Considering the relevés of the more natural upper sections we can say, that the three tree species characteristic of the willow-poplar gallery forests (*Salix alba, Populus nigra, Populus alba*) were not segregated exactly on association-level, they occurred together in most of the stands. This mixed species-composition was confirmed by the multivariate analyses, too. The explanation of this phenomenon should be that the natural processes could not play an important role and the segregation of the association-forming species could not be realized effectively at the extremely fragmented and reduced floodplain. The relief differences, which are important in the development of certain association types, are mainly absent from the recent inundation area, too.

4. Constant and dominant species in the shrub layer was *Rubus caesius* in each section. According to literature data, the *Rubus caesius* facies of the gallery forests is one of the most widespread types, and it could turn into a secondary, strongly degraded form, which is very poor in species, due to the permanent and intensive grazing (Kárpáti 1958/a). In his compendium, Soó also distinguished a *Rubus caesius* facies, and qualified it as a secondary type (Soó 1964). Timár mentioned that the gallery forests along the dikes were pastured almost everywhere in the lower Tisza section, and therefore they became weedy, and *Rubus caesius* also dominated these stands (Timár 1953). According to Borhidi and Kevey, the increase of *Rubus caesius* indicates the drying of the area (Borhidi *et al.* 1999).

With the previous statements we wanted to emphasize that the reason why *Rubus caesius* could become one of the most dominant elements in the floodplain forests is the gradual drying up of the area after the water regulation. Grazing has the same effect as the drying due to the strong trampling.

5. The dominance of *Urtica dioica* in the herb layer is indicative of the high nitrogen content of the soil. According to the ecological indicator values by Borhidi, it indicates the hyperfertilized soils (Horváth *et al.* 1995).

6. *Bidens tripartitus* appeared in the stands of the lowland section and along the tributaries with quite high constancy values. We experienced that in the herb layer the real abundance of *Bidens tripartitus* and some other species (mainly the invasive plants as *Amorpha fruticosa, Acer negundo* etc.) could be estimated best

at the end of summer. Earlier the seeds are dormant, therefore it is easy to underestimate the abundance of these species.

7. *Calystegia sepium* performed with high (IV-V) constancy values in the archive relevés, but in the recent vegetation it became insignificant (K=I-II). On the basis of the ecological indicator values, this species indicates nitrogen-rich and water-saturated soil (Horváth *et al.* 1995). Consequently, its decrease along the River Tisza is connected with the drying processes.

8. Comparing the Romanian and the Hungarian sections of the Maros, we found that there was a lot more species with high constancy values at the Romanian section: 19 species occurred with IV-V constancy. Its explanation should be that species can still spread easily among the stands there; the fragmentation of the natural habitats is not so considerable.

9. Several data support the role of the River Tisza and its tributaries in maintaining the species-dispersion (Gallé *et al.* 1995, Gallé 2002, Gallé 2003). This process is traceable by the changing constancy values of the easily spreading invasive species in different river sections and in time.

9.1. *Fraxinus pennsylvanica* was present with low constancy and abundance (K=1, range of the Braun Blanquet scale: +-1) in the archive relevés of the Upper-Tisza, but in the recent relevés it became very dominant element (K=V: southern frontier-Csongrád, Csongrád-Szolnok, Köröszug, K=III: Bodrogzug). Its spreading was forced by the natural disturbances, the intensive human land-use and the increasing proportion of the forest plantations.

9.2. In recent data, *Amorpha fruticosa* occurred with high abundance and constancy (K= IV-V) in most of the stands on the whole Hungarian section of River Tisza, contrasting with the archive records, in which it was found with far lower constancy values (K=I-II).

Amorpha fruticosa was missing from the 1991 relevés of the Romanian section of River Maros, but in other sections it was present with constancy III-IV. *Amorpha fruticosa* was detected with constancy III by Tóth at the Hungarian section in the 1960s.

9.3. The spreading process of *Fraxinus pennsylvanica* was very similar to that of *Amorpha fruticosa. Fraxinus pennsylvanica* was absented in the archive and recent relevés of the Romanian section, but was present with constancy III at the Hungarian section of river Maros.

From the above data, it can be assumed that these species spread from the inundation area of River Tisza towards the Romanian section of River Maros oppositely with the direction of flow. This is due to the fact that *Fraxinus pennsylvanica* was planted mainly along the Tisza basin, and spread spontaneously towards the Maros.

9.4. *Acer negundo* did not appear in as large quantities in the inundation area as *Fraxinus pennsylvanica*. It was found in larger proportion mainly in the lowland

section of Tisza. It occurred also along the tributaries with abundance increasing in time.

9.5. According to some field experiences the colonisation of the above mentioned invasive species should depend on the quantity of seeds arriving at a single habitat-patch, and is not influenced by the relief, soil and microclimate conditions of the habitat.

Coenological characteristics of the flora of the willow scrubs and gallery forests

We compared the willow scrub and gallery forest communities on the basis of the coenological affinity of their flora. We used the revised Soó's coenosystematic classification system (Horváth *et al.* 1995), and evaluated the flora of the relevés along the river Tisza and its tributaries (since the sampling methods were not standardized the cover values were not considered, we used only the presence/absence values). It was necessary to set up a new category for the adventive species missing from the system, because they have a strong effect on the floodplain plant communities.

Altogether 252 species were recorded in the relevés of the willow scrubs, including the introduced alien species, too. The analysis was performed from 240 species because the remaining species were not classified in the Soó's system. The relevés of the gallery forests consisted of 433 species, 416 of which were included in the analysis.

Conclusions at division level

The species of the willow scrub communities were classified in 9 categories plus in an adventive category. The gallery forest species belonged to 13+1 (adventive) categories. This difference may be caused by more variable habitat conditions in the gallery forest stands.

Eighty eight per cent of the flora of willow scrubs and 80 % of the gallery forest species were included in the following four categories:

1. Indifferent species

This group is the largest in both community types. It gives 39 % of the willow scrub flora, and 28 % of the gallery forest flora. These species are generalists and have wide tolerance spectrum, thus the regularly developing sediment surfaces may provide an ideal colonization site for them. These conditions are more frequent in the habitats of the willow scrub (shores and sandbanks), therefore this could partly explain the marked differences among the flora of the two associations.

Another explanation should be the different level of organization of the two associations. The more extreme habitat conditions of the willow scrubs could not

allow the development of a plant community with highly organized and more or less constant species pool. Alluvial soils developing usually every year could provide excellent colonization sites for any kind of propagules. However, the gallery forests developed on a little higher relief in wider extent, thus the organization of the stands is higher. Later association could filter the species pool.

2. *Chenopodio-Schleranthea*

The division contains the plant associations of the disturbed habitats. This category roughly gives the same proportion of the flora in the case of both associations (willow scrubs: 28 %, gallery forests: 24 %). This indicates that the two habitats do not differ significantly from each other in respect of the disturbation effects.

3. *Cypero-Phragmitea*

Greater difference was detected between the two associations in respect of the *Cypero-Phragmitea* species. The proportion of these species in the willow scrubs – 14 % – gives almost the double to the species of the gallery forests (8 %). This strong difference may be explained by the number of *Nanocyperion* species colonizing in high proportion on the crude alluvial soils along the riverside.

Considering the species number instead of the proportion, the result is different a bit: partly different species (elements of large sedge communities, reed beds and amphibious communities) but broadly in the same number are present in the two community types.

4. *Querco-Fagea*

The species of this division are characteristic of the gallery forests. They give 20,6 % of the total species pool. Regarding the willow scrubs this category shares just 6,6 % in the flora. This shows the close connection of the gallery forests towards the mesophilous oak woods and the hardwood forests.

Floristic characters at lower syntaxonomic levels

The species of *Calystegion sepium* alliance were represented in both community types in a considerable proportion (they gave 3,7 % of the flora of the willow scrubs and 5,3 % of the gallery forest). This means 9 species in the willow scrubs, and 13 species in the gallery forests. All the 9 species of the willow scrubs occurred also in the gallery forest. Certain adventive species associated so strongly to this coenotaxon that they may be considered as members of the group

Calystegion sepium (for example: *Acer negundo, Amorpha fruticosa, Echinocystis lobata*).

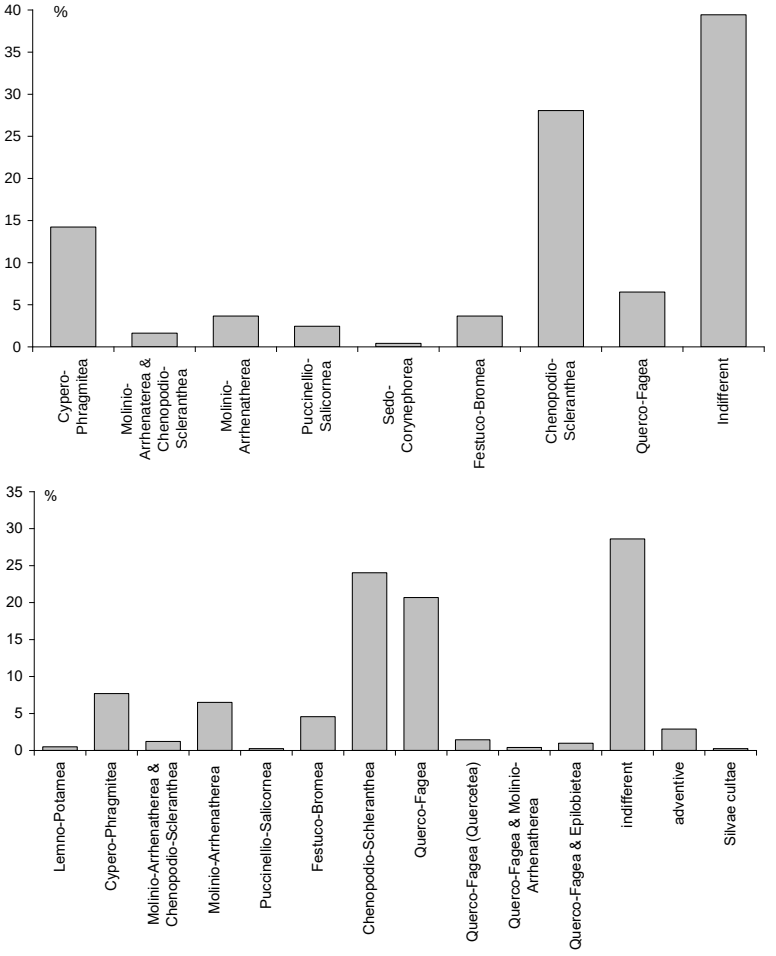

Fig. 3. Percentage distribution of the species belonging to coenosystematic categories at division level. The indifferent and more or less indifferent species are put together.

Salicion triandrae and *Salicion albae* species were present with almost the same weight in the species pool of the willow scrubs. *Salicion triandrae* was represented with the same two species (*Salix triandra, S. viminalis*) in both associations. Six species of *Salicion albae* alliance occurred only in the gallery forests and gave 2,1 % of the flora (*Leucojum aestivum, Rumex obtusifolius, Epipactis purpurata, Carduus crispus, Vitis sylvestris* and *Alnus incana*).

As it was expected, the order *Nanocyperetalia* shared in the flora of the willow scrubs in higher proportion (4,58 %). This may refer to the favourable habitat conditions rather than the biotic connections.

The species of *Molinietalia* order shared in the flora of the gallery forests in 2,6 %. Species of large sedge communities and flood swards could colonize the herb layer since the canopy of this forest was open.

Fagetalia species gave 1,25 % of the flora of the willow scrubs and 4,08 % of the gallery forests (*Alno-Padion* shared in 0,96 %). This indicates again the floristic connection between the gallery forest and mesophylous oak woods and hardwood forests.

As for the composition of the flora of the willow scrubs, 70,4 % of its species were also the components of the gallery forests. Further species are ranked as cultivated plants (2,8 %), amphibious and ruderal species (26,8 %). Thus, no species was found characteristic exclusively for the willow scrubs.

There are several causes of this:

1. Influences of the coenotaxonomic system on the sampling methods: at the beginning, the willow scrubs were not considered a separate association, thus during the sampling of the gallery forests some parts of the willow scrub stands were included in the quadrate, and its species were recorded as the species of the gallery forests.

2. The floristic composition of these two habitat-types is very similar. The flora of the willow scrubs differs from that of the gallery forest mainly in the dominant tree species which determine the physiognomy of the stands, and in the presence of *Nanocyperion* species. The lower shrub- and the herb layers contain almost the same species. This may be explained with the natural disturbations which are the most important processes, thus influencing the species composition. The disturbance tolerant species are present in both associations; certain differences are detected on stand level depending on the successful colonization after the floods. Considering the abundance relation of the species, however, we found greater differences among the two vegetation types.

Adventive species in the floodplain forests

Most of the adventive species have already been classified in certain coenosystematic categories, but considering their very important effect on the floodplain forest communities, we analyzed them in more detail. We used the categories of the invasive neophytes for the separation of the adventive species according to Mihály *et al.* (2004).

Fifteen invasive neophyte species occurred in the willow scrubs (6,25 % of the flora): *Acer negundo, Amaranthus retroflexus, Ambrosia artemisiifolia, Amorpha fruticosa, Conyza canadensis, Echinocystis lobata, Erigeron annuus* ssp. *strigosus,*

Galinsoga parviflora, Oxalis stricta, Robinia pseudo-acacia, Solidago gigantea ssp. *serotina, Xanthium italicum, Xanthium spinosum, Oenothera biennis, Panicum miliaceum.*

The following invasive neophytes were present in the gallery forests (29 species, 6,9 % of the flora): *Acer negundo, Ailanthus altissima, Ambrosia artemisiifolia, Amorpha fruticosa, Artemisia annua, Bidens frondosa, Celtis occidentalis, Conyza canadensis, Cuscuta campestris, Cyperus difformis, Echinocystis lobata, Erigeron annuus* ssp. *annuus, Erigeron annuus* ssp. *strigosus, Fallopia japonica, Fraxinus pennsylvanica, Galinsoga parviflora, Helianthus decapetalus, Impatiens parviflora, Juncus tenuis, Oenothera biennis, Oxalis stricta, Parthenocyssus inserta, Robinia pseudo-acacia, Rudbeckia laciniata, Solidago canadensis, Solidago gigantea* ssp. *serotina, Vitis riparia, Xanthium italicum, Xanthium spinosum.*

Above species lists suggest that significantly fewer invasive neophytes occurred in the willow scrubs than in the gallery forests, and this contradicts to the opinions (in connection with the indifferent species) that the willow scrubs are more open to the generalist species, and their stands are less organized than those of the gallery forests. The virtual contradiction should be due to the timing of the sampling: the relevés of the willow scrubs were taken in the 1950s when much fever invasive species should have been present in the floodplain of river Tisza. This hypothesis needs further investigations to verify because probably the forest management and land use affected also the colonization and spread of the adventive species.

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